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(21)Application number : 2001-204106 (71)Applicant : HITACHI MEDICAL CORP

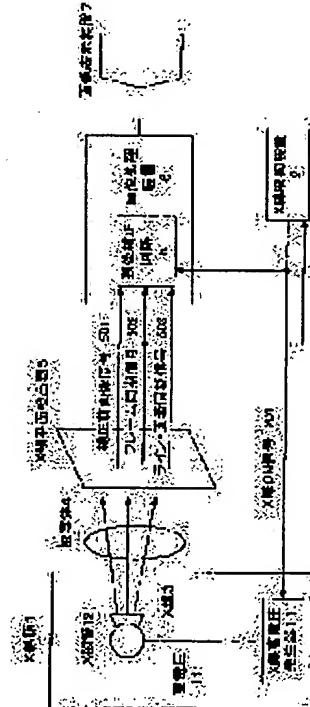
(22)Date of filing : 04.07.2001 (72)Inventor : ISHIKAWA KEN

(54) X-RAY EQUIPMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an X-ray equipment applicable to acquiring an X-ray image of a continuous frame, and capable of highly accurately correcting an after image.

SOLUTION: This X-ray equipment has an X-ray tube 12 for irradiating an object with an X-ray, an X-ray control device 2 for controlling the X-ray tube 3, an X-ray detector 5 for detecting the X-ray passed through the object 4, and an after image correcting circuit 8 for correcting an after image characteristic of the X-ray detector 5. This after image correcting circuit 8 switches the correction processing content according to irradiation or a stoppage of the irradiation of the X-ray by an X-ray source. This switching is performed by predicting a correction quantity with every picture element of respective frames and a correction quantity of the next frame from an image signal of this frame when irradiating the X-ray, and predicting the correction quantity of the next frame from the image signal of this frame when stopping the irradiation of the X-ray. Thus, the after image can be corrected even when irradiating the X-ray, and can be highly accurately corrected by using the image signal when stopping the irradiation.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to suitable X-rays equipment to obtain few fluoroscopy images of an after-image using the X-ray flat-surface detector with which the square shape image which is applied to the X-rays equipment used for a medical diagnosis, especially does not have distortion at a small light weight is obtained.

[0002]

[Description of the Prior Art] In the conventional X-rays equipment, the X-ray detector which combined the X-ray film, the X-ray image intensifier, and the CCD camera detected the X-ray image which penetrated the photographic subject, it displayed on the film, the CRT display, etc., and a medical practitioner's interpretation of radiogram has been presented. In recent years, the pixel which consists of an MOS mold switch and a photodiode for example, on an amorphous silicon substrate has been arranged to the matrix as an X-ray detector, and the X-ray flat-surface detector of a semi-conductor mold which arranged the fluorescent substance which absorbs and changes an X-ray on it was developed. An X-ray flat-surface detector is easy handling at a small light weight as compared with the conventional X-ray image intensifier and the combination of a CCD camera, and it has the advantage from which a square shape image without distortion is obtained.

[0003] On the other hand, the electron excited with light by the trap level under the conduction band of a photodiode is captured by the X-ray flat-surface detector, and the after-image which is a second unit and is maintained and which is long duration comparatively exists in it by mechanism which serves as a lightwave signal current again gone up and delayed to the conduction band with heat. Such a long duration after-image serves as hindrance of observation, when acquiring the X-ray picture of the frame which continued with the fixed time interval like especially radioscopy and observing it as an animation.

[0004]

[Problem(s) to be Solved by the Invention] In order to remove the effect of such an after-image, establishing an after-image amendment means to amend the after-image property of an X-ray detector, in the image processing system which processes the picture signal which an X-ray detector outputs has been performed since before. For example, with the X-ray inspection equipment which has an X-ray picture sensor matrix and an amendment unit given in the ** table No. 505985 [2000 to] official report, it is the device which predicts and amends the amount of after-image amendments using the "criteria picture signal" when X-ray irradiation is not performed.

[0005] Since this approach is prediction using the "criteria picture signal" which consists only of pure afterglow, while it can perform high amendment of precision comparatively, when acquiring the X-ray picture of the frame which continued with the fixed time interval like radioscopy, it cannot be applied.

[0006] It is the approach of predicting the correction value of the following frame from the picture signal of the frame preceded for X-ray picture acquisition of a continuous frame like radioscopy on the other hand in the X-ray picture formation approach and X-ray picture formation system of JP,2000-

175892,A. However, though it was nothing-amended or the picture signal of the precedence frame which becomes the origin of amendment was amended, when not perfect, the error of amendment will be accumulated and it will become low amendment of precision comparatively.

[0007] For this reason, it was difficult to obtain the fluoroscopy image which performed after-image amendment with a high precision with the above-mentioned conventional technique with the X-rays equipment which used the X-ray flat-surface detector of a semi-conductor mold.

[0008] Therefore, the key objective of this invention is to offer the X-rays equipment which can apply also to X-ray picture acquisition of the continuous frame, and can perform highly precise after-image amendment.

[0009]

[Means for Solving the Problem] In this invention X-rays equipment, the X-rays equipment of this invention is characterized by to equip a photographic subject with X line source which irradiates an X-ray, the X-ray control unit which controls this X line source, the X-ray detector which detects the X-ray which penetrated this photographic subject, and an after-image amendment means amend the after-image property of an X-ray detector, to detect an exposure halt during the exposure of the X-ray by X line source, and for an after-image amendment means to change the contents of amendment processing. Thereby, while after-image amendment is possible also in X-ray irradiation, high amendment of the precision using the picture signal under exposure halt is also enabled.

[0010] The contents change of processing of the above-mentioned after-image amendment is applicable to the general X-rays equipment using an X-ray detector with an after-image property. Especially, handling is easy at a small light weight, and the after-image property that a square shape image without distortion is the fault of an X-ray flat-surface detector further can amend with a sufficient precision because an X-ray detector is an X-ray flat-surface detector of a semi-conductor.

[0011] Moreover, in order for the above-mentioned after-image amendment means to detect whether the X-ray by X line source is irradiating, or it is an exposure halt, it can attain easily by using the control signal with which an X-ray control unit controls X line source.

[0012] Furthermore, case [whose X-ray detector which detects an X-ray is / like / this invention / the radioscopy which outputs the picture signal of the frame which continued with the fixed time interval], it is suitable. In that case, when the X-ray according [the amendment processing by the after-image amendment means] to X line source is irradiating, from the amount of amendments for every pixel of each frame, and the picture signal of this frame, the amount of amendments of degree frame is predicted and, in an exposure halt of the X-ray by X line source, the amount of amendments of the picture signal of this frame to degree frame is predicted. If it does in this way, while after-image amendment is possible also in X-ray irradiation, high amendment of the precision using the picture signal under exposure halt will also become possible.

[0013]

[Embodiment of the Invention] Hereafter, the example of the X-rays equipment of this invention is explained with reference to a drawing. Drawing 1 is the block diagram showing the whole X-rays equipment configuration of this invention. The X line source 1 is equipped with the X-ray high-voltage generator 11 and X-ray tube 12. The X-ray high-voltage generator 11 is controlled by the X-ray ON signal 201 from the X-ray control unit 2, when the X-ray ON signal 201 is a value 1, impresses the high voltage 111 to X-ray tube 2, and generates X-ray 3.

[0014] X-ray 3 which penetrated the photographic subject 4 is detected by the X-ray flat-surface detector 5, is changed into the digital picture signal 501 before amendment, and is inputted into an image processing system 6. The X-ray flat-surface detector 5 arranges to a matrix the pixel which consists of an MOS mold switch and a photodiode on an amorphous silicon substrate, and arranges the fluorescent substance which absorbs and changes an X-ray on it. this X-ray flat-surface detector 5 -- the exposure of X-ray 3 -- irrespective of how, the picture signal of the frame which continued with the fixed time interval was outputted, the frame alignment signal 502 of an image which synchronized with changing and Rhine, and Rhine which synchronized with changing and the pixel synchronizing signal 502 of a pixel were inputted into the image processing system with the picture signal 501 before

amendment, and the timing of amendment and collection of image data is determined.

[0015] The frame alignment signal 502 is inputted also into the X-ray control unit 2, an image changes, the time of this frame alignment signal 502 being a value 1 comes out of the X-ray control unit 2, and it gets to know a certain thing, makes the X-ray ON signal 201 a value 1 between them, and is made to irradiate X-ray 3. An image processing system 6 amends and collects, the image data which performed image processings, such as a spatial filter, is outputted to an image display device 7, and a diagnosis is presented with it.

[0016] The electron excited with light by the trap level under the conduction band of a photodiode is captured by the X-ray flat-surface detector 5 of this invention X-rays equipment, and the after-image of long duration exists in it comparatively by becoming the lightwave signal current again gone up and delayed to the conduction band with heat, and it becomes the hindrance of observation if it remains as it is. Therefore, the after-image amendment circuit 8 which amends the after-image property of the X-ray flat-surface detector 5 is formed in the image processing system 6. The X-ray ON signal 201 from the X-ray control unit 2 has inputted into the after-image amendment circuit 8, and the after-image amendment circuit 8 is constituted so that an exposure halt during the exposure of an X-ray may be detected with the X-ray ON signal 201 and the contents of amendment processing may be changed.

[0017] Drawing 2 is the block diagram showing the configuration of the after-image amendment circuit 8. The picture signal 821 after amendment is made from there being the image memory 81 for amendment and a subtractor 82 in the after-image amendment circuit 8, reading this frame amendment picture signal 811 that is equivalent to the amount of after-images predicted from the image memory 81 for amendment from the X-ray flat-surface detector 5 synchronizing with the picture signal 501 before amendment of each pixel for every pixel, and subtracting from the picture signal 501 before amendment with a subtractor 82. The frame alignment signal 502, and Rhine and the pixel synchronizing signal 503 which are sent along with the picture signal 501 before amendment from the X-ray flat-surface detector 5 were inputted into the memory controller 81, and the image memory address signal 831 for amendment for reading this frame amendment picture signal 811 from the image memory 81 for amendment for every pixel there and the renewal signal 832 for amendment of image memory were made, and they are inputted into the image memory 8 for amendment.

[0018] The image memory 81 for amendment is the semiconductor memory of the dual port mold in which an entry of data and an output are possible to coincidence. While this frame amendment picture signal 811 of each pixel is read from the address specified by the renewal signal 832 for amendment of image memory from this image memory 81 for amendment by the image memory address signal 831 for amendment at that time, the frame [degree] amendment picture signal 841 equivalent to the amount of after-images expected to the following frame is written in for every pixel to the same address.

[0019] The frame [degree] amendment picture signal 841 is the output of the renewal LUT 84 for amendment of an image which is a look-up table (LUT) by semiconductor memory. In the top address of the renewal LUT 84 for amendment of an image, during the fluoroscopy which is the output of the /idle signal generator 85 during fluoroscopy, the picture signal 501 before amendment inputs into the middle address, and this frame amendment picture signal 811 has inputted [the /idle signal 851] into the lower address. During fluoroscopy, a frame alignment signal 502 inputs from the X-ray flat-surface detector 5, the X-ray ON signal 201 inputs into the /idle signal generator 85 from the X-ray control unit 2, and the /idle signal 851 is made during fluoroscopy. During fluoroscopy, when X-ray 3 is irradiated, while the image detected with the X-ray flat-surface detector 5 is read, the /idle signal 851 serves as the value 1 which shows under fluoroscopy, and when other, it serves as the value 0 which shows an idle state. That is, since the image by X-ray 3 irradiated there when the between to the back end of the back end of the section whose frame alignment signal is a value 1 as shown in drawing 3 to a degree was dealt with as the frame section 503 and the X-ray ON signal became a value 1 in a certain frame section 503 is read in the following frame section 503, the /idle signal 851 serves as a value 1 during fluoroscopy during the following frame section 503. In this example, as shown in drawing 3, the X-ray ON signal 201 serves as a value 1 in pulse, while the image with which a frame alignment signal 502 serves as a value 1 changes, and X-ray 3 is irradiated in pulse there.

[0020] The functional relation which predicts the frame [degree] amendment picture signal 841 from the picture signal 501 before amendment and this frame amendment picture signal 811 at the time of X-ray irradiation is written in the field whose top address of the renewal LUT 84 for amendment of an image is 1. When a trap level is almost single, the frame [degree] amendment picture signal 841 equivalent to the amount of amount anticipation of after-images of the following frame serves as a function of the electron number saved after the X-ray irradiation of this frame at the trap level. Although the former is the function of this frame amendment picture signal 811 equivalent to the amount of after-image anticipation of this frame although this electron number turns into an electron number saved before the X-ray irradiation of this frame at the trap level, and a function of the electron number excited by the conduction band by the X-ray irradiation of this frame, and the latter serves as a function of the picture signal of this frame after removing the effect of an after-image, from the picture signal 501 before amendment, this lengthens this frame amendment picture signal 811, and is expected. Therefore, it is possible in approximation to predict the frame [degree] amendment picture signal 841 from the picture signal 501 before amendment and this frame amendment picture signal 811. In fact, functional relation is experientially called for using the result of a simple model experiment, uses the computer which is not illustrated in an image processing system 6, and is written in through the data bus linked to the renewal LUT 84 for amendment of an image which is not illustrated. However, in this functional relation, strictly, since that energy distribution also poses a problem in fact at a trap level besides the electron number which there is width and was able to be stored, only such an easy model cannot describe it but an amendment error produces [approximation] it. Furthermore, since this after-image amendment is the recursive approach of predicting the frame [degree] amendment picture signal 841 using this frame amendment picture signal 811, it has the possibility of are recording with error.

[0021] In this invention, such error are recording is canceled between idle states. That is, since the /idle signal 851 serves as a value 0 during fluoroscopy in an idle state, the top address of the renewal LUT 84 for amendment of an image will predict the frame [degree] amendment picture signal 841 using the field which is 0. Although the functional relation which predicts the frame [degree] amendment picture signal 841 from the picture signal 501 before amendment and this frame amendment picture signal 811 can be written also in this field, in practice, this frame amendment picture signal 811 is invalid, and the functional relation which predicts the frame [degree] amendment picture signal 841 only from the picture signal 501 before amendment is written in. In an idle state, the picture signal 501 before amendment will serve as only an after-image, if a noise component is removed. Therefore, the frame [degree] amendment picture signal 841 can be predicted without an are recording error in a high precision from the picture signal 501 before amendment by searching for beforehand the attenuation factor according to the amount of after-images. in this way, the frame under first fluoroscopy to which the frame [degree] amendment picture signal 841 searched for slipped out of the idle state -- being also alike -- since it is applied, the are recording error of amendment under fluoroscopy is canceled by going via an idle state.

[0022] It cannot be overemphasized that various deformation is possible for this invention, without being limited to the above-mentioned example. That is, since the after-image of long duration which was made an issue of here exists not only in an X-ray flat-surface detector but in the X-ray detector using an X-ray image intensifier and the camera tube and the detector using the fluorescent substance of long afterglow, this invention is effective also in them.

[0023] In order that the after-image amendment circuit 8 may detect an exposure halt during the exposure of an X-ray, the X-ray ON signal 201 from the X-ray control unit 2 is used, but when the internal signal of the X-ray high-voltage generator 11 can be pulled out, the precision of those who used it control goes up. In addition, an X-ray sensor may be separately formed in an X-ray detector; the X-ray detecting signal from this sensor may be used, or at least one pixel of an X-ray flat-surface detector may be used as an X-ray detection sensor, and an exposure halt during the exposure of an X-ray may be detected using the detecting signal of that sensor.

[0024] Also when the output of the picture signal from an X-ray detector is not a fixed time interval, application of this invention is possible in detecting a time interval, if there are allowances to add the

address input according to fluctuation of a time interval to LUT84 for renewal of an image for amendment, and inputting into LUT84 for renewal of an image for amendment.

[0025] When the idle signal 851 is a value 0, it is also the change of a kind of amendment processing to fix the pixel value of the picture signal 821 after amendment to 0 instead of the output of a subtractor 82. However, if the frame [degree] amendment picture signal 841 is written in the image memory 81 for amendment by the above-mentioned approach also in that case, when it changes into the condition under fluoroscopy, it can respond to amendment processing immediately.

[0026]

[Effect of the Invention] As explained above, according to this invention, after-image amendment is attained also in X-ray irradiation by detecting an exposure halt among X-ray irradiation, and changing the contents of amendment processing of an after-image amendment means to amend the after-image property of an X-ray detector, using a control signal, from an X-ray control unit.

[0027] Moreover, when high amendment of precision can be performed using the picture signal under exposure halt, amendment without an are recording error is also possible. Especially, in the case of the X-ray flat-surface detector of a semi-conductor, handling is easy at a small light weight, and the after-image property which is the fault can amend with a sufficient precision, maintaining the advantage that a square shape image without distortion is obtained.

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CLAIMS**[Claim(s)]**

[Claim 1] The X-rays equipment characterized by for the above-mentioned after-image amendment means to change the contents of amendment processing according to an exposure halt during the exposure of the X-ray by the above-mentioned X line source in the X-rays equipment which equips a photographic subject with X line source which irradiates an X-ray, the X-ray control unit which controls this X line source, the X-ray detector which detects the X-ray which penetrated this photographic subject, and an after-image amendment means amend the after-image property of an X-ray detector.

[Claim 2] X-rays equipment according to claim 1 with which the X-ray detector which detects an X-ray is characterized by being the X-ray flat-surface detector of a semi-conductor.

[Claim 3] X-rays equipment according to claim 1 characterized by using the control signal with which an X-ray control unit controls X line source in order that an after-image amendment means may detect an exposure halt during the exposure of the X-ray by X line source.

[Claim 4] X-rays equipment according to claim 1 characterized by outputting the picture signal of a frame with which the X-ray detector which detects an X-ray continued with the fixed time interval.

[Claim 5] It is the X-rays equipment according to claim 4 which predicts the amount of amendments of degree frame and is characterized by predicting the amount of amendments of the picture signal of this frame to degree frame in an exposure halt of the X-ray by X line source from the amount of amendments for every pixel of each frame, and the picture signal of this frame when the X-ray according [the amendment processing by the after-image amendment means] to X line source is irradiating.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the functional block diagram showing the whole X-rays equipment configuration of this invention.

[Drawing 2] It is the functional block diagram showing the configuration of an after-image amendment circuit.

[Drawing 3] It is the timing chart which shows change of a /idle projection signal during fluoroscopy.

[Description of Notations]

- 1 X Line Source
- 2 X-ray Control Unit
- 3 X-ray
- 4 Photographic Subject
- 5 X-ray Flat-Surface Detector
- 6 Image Processing System
- 7 Image Display Device
- 8 After-image Amendment Circuit
- 81 Image Memory for Amendment
- 82 Subtractor
- 83 Memory Controller
- 84 Renewal Look-up Table for Amendment of Image
- 85 It is /Idle Signal Generator During Fluoroscopy.
- 201 X-ray ON Signal
- 501 Front [Amendment] Picture Signal
- 502 Frame Alignment Signal
- 503 Rhine and Pixel Synchronizing Signal
- 811 This Frame Amendment Picture Signal
- 821 After [Amendment] Picture Signal
- 831 Image Memory Address Signal for Amendment
- 832 Renewal Signal for Amendment of Image Memory
- 841 Frame [Degree] Amendment Picture Signal
- 851 It is /Idle Signal During Fluoroscopy.

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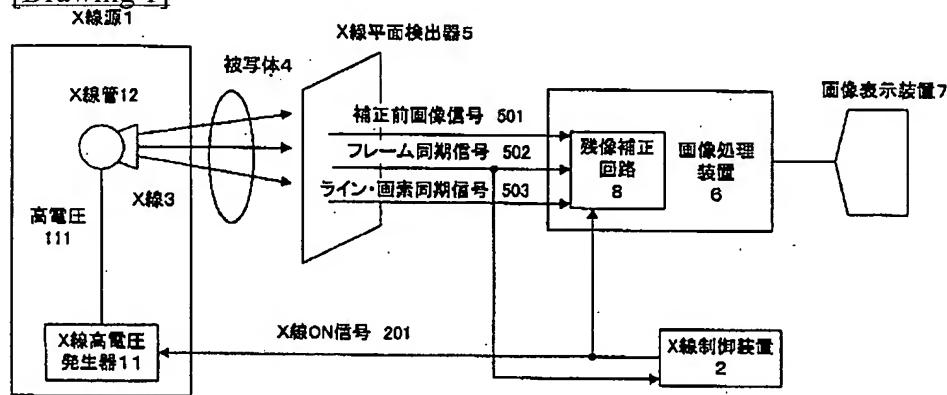
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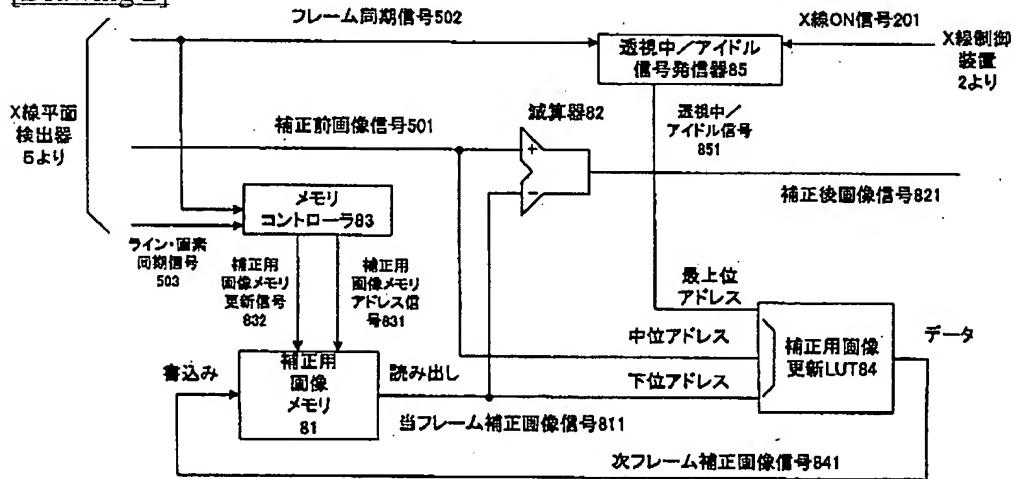
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DRAWINGS

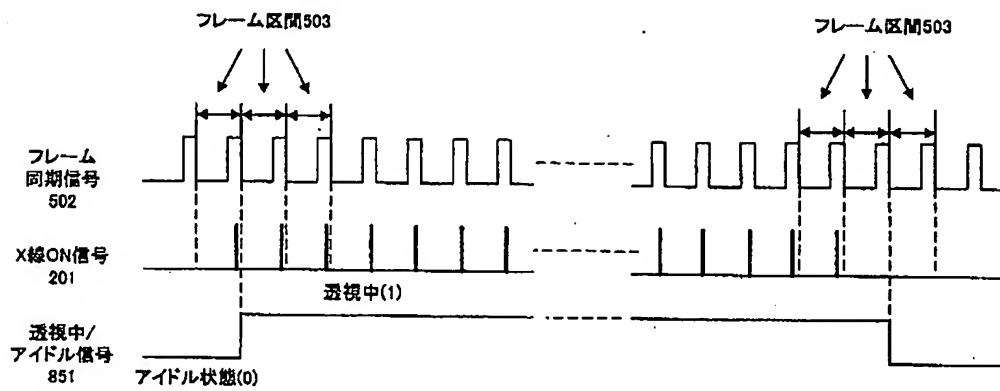
[Drawing 1]



[Drawing 2]



[Drawing 3]



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